

# Understanding Basic Concept of Electrical and Electronic Systems

Asadullah Shah



IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

# **UNDERSTANDING BASIC CONCEPT OF ELECTRICAL AND ELECTRONIC SYSTEMS**

---

**Editors**

Asadullah Shah



**IIUM Press**

Published by:  
IIUM Press  
International Islamic University of Malaysia  
First Edition, 2011  
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

Bibliography p.  
Includes Index  
ISBN

ISBN: 978-967-418-116-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM  
(Malaysian Scholarly Publishing Council)

Printed by:  
**IIUM PRINTING SDN. BHD.**  
No. 1, Jalan Industri Batu Caves 1/3  
Taman Perindustrian Batu Caves  
Batu Caves Centre Point  
68100 Batu Caves  
Selangor Darul Ehsan

# CONTENTS

---

|   |            |
|---|------------|
| <b>DEDICATION.....</b>                            | <i>iii</i> |
| <b>PREFACE.....</b>                               | xiii       |
| <b>ACKNOWLEDGEMENT.....</b>                       | <i>xiv</i> |
| <b>1. FAMILIARIZATION WITH MULTIMETER .....</b>   | <b>1</b>   |
| 1.0 Abstract.....                                 | 1          |
| 1.1 Introduction.....                             | 1          |
| 1.2 Types of Multimeters:.....                    | 2          |
| 1.2.1 Digital MMs.....                            | 2          |
| 1.2.2 Analog MMs.....                             | 2          |
| 1.3 Accuracy .....                                | 3          |
| 1.4 Safety Information .....                      | 3          |
| 1.5 References:.....                              | 5          |
| <b>2. USING THE MULTIMETER .....</b>              | <b>6</b>   |
| 2.0 Abstract:.....                                | 6          |
| 2.1 Range .....                                   | 6          |
| 2.2 Automatic Touch Hold Mode .....               | 7          |
| 2.3 Continuity Test.....                          | 10         |
| 2.4 Current .....                                 | 11         |
| 2.5 References:.....                              | 12         |
| <b>3. FAMILIARIZATION WITH OSCILLOSCOPE .....</b> | <b>13</b>  |
| 3.0 Abstract.....                                 | 13         |
| 3.1 Introduction .....                            | 13         |
| 3.2 Analog and Digital.....                       | 14         |
| 3.3 Types of Waves.....                           | 15         |
| 3.4 Sine Waves .....                              | 16         |
| 3.5 Square and Rectangular Waves.....             | 16         |
| 3.6 Sawtooth and Triangle Waves .....             | 17         |

|     |   |    |
|-----|---|----|
| 3.7 | References:                                     | 17 |
| 4.  | SIGNALS   | 18 |
| 4.0 | Abstract  | 18 |
| 4.1 | Step and Pulse Shapes                           | 18 |
| 4.2 | Waveform Measurements                           | 19 |
| 4.3 | Frequency and Period                            | 19 |
| 4.4 | Voltage   | 20 |
| 4.5 | Phase   | 20 |
| 4.6 | References:                                     | 22 |
| 5.  | PROBES  | 23 |
| 5.0 | Abstract  | 23 |
| 5.1 | Using Passive Probes                            | 24 |
| 5.2 | Using Active Probes                             | 26 |
| 5.3 | Using Current Probes                            | 26 |
| 5.4 | Where to Clip the Ground Clip                   | 27 |
| 5.5 | Setting the Controls                            | 27 |
| 5.6 | References:                                     | 28 |
| 6.  | CONTROL PANEL OF AN OSCILLOSCOPE                | 29 |
| 6.0 | Abstract:                                       | 29 |
| 6.1 | Front Panel Control Sections of an Oscilloscope | 29 |
| 6.2 | Vertical Controls                               | 30 |
| 6.3 | Position and Volts per Division                 | 31 |
| 6.4 | Bandwidth Limit                                 | 32 |
| 6.5 | Channel Invert                                  | 32 |
| 6.6 | Alternate and Chop Display                      | 32 |
| 6.7 | References:                                     | 33 |
| 7.  | OPERATION OF AN OSCILLOSCOPE                    | 34 |
| 7.0 | Abstract:                                       | 34 |
| 7.1 | Math Operations                                 | 34 |

|       |   |    |
|-------|---|----|
| 7.2   | Display Controls .....                  | 35 |
| 7.3   | Horizontal Controls.....                | 35 |
| 7.4   | Position and Seconds per Division ..... | 36 |
| 7.5   | Time Base Selections .....              | 37 |
| 7.6   | Trigger Position .....                  | 37 |
| 7.7   | Magnification .....                     | 38 |
| 7.8   | XY Mode.....                            | 38 |
| 7.9   | References: .....                       | 38 |
| 8.    | MEASUREMENT TECHNIQUES .....            | 39 |
| 8.0   | Abstract: .....                         | 39 |
| 8.1   | Oscilloscopes display .....             | 39 |
| 8.2   | Voltage Measurements .....              | 40 |
| 8.3   | Time and Frequency Measurements .....   | 43 |
| 8.4   | Pulse and Rise Time Measurements.....   | 44 |
| 8.5   | Phase Shift Measurements.....           | 44 |
| 8.6   | References: .....                       | 46 |
| 9.    | RESISTOR COLOR CODES .....              | 47 |
| 9.0   | Abstract: .....                         | 47 |
| 9.1   | Introductory Information:.....          | 47 |
| 9.2   | First the code .....                    | 47 |
| 9.3   | The mnemonic .....                      | 48 |
| 9.4   | How to read the code .....              | 48 |
| 9.4.1 | Zero-ohm resistor .....                 | 49 |
| 9.4.2 | Rheostat .....                          | 50 |
| 9.4.3 | Potentiometer .....                     | 50 |
| 9.5   | References: .....                       | 51 |
| 10.   | SOLDERING IRON PRACTICE.....            | 52 |
| 10.0  | Abstract: .....                         | 52 |
| 10.1  | Introduction: .....                     | 52 |

|        |  |    |
|--------|--|----|
| 10.2   | Tools Needed:                                    | 53 |
| 10.2.1 | Soldering Iron                                   | 53 |
| 10.2.2 | The tip of iron                                  | 53 |
| 10.2.3 | Soldering iron stand                             | 54 |
| 10.2.4 | Solder   | 54 |
| 10.2.5 | Solder pump                                      | 54 |
| 10.3   | Safety Precautions:                              | 55 |
| 10.4   | References:                                      | 55 |
| 11.    | PROCEDURE OF SOLDERING IRON PRACTICE             | 56 |
| 11.0   | Abstract:  | 56 |
| 11.1   | Handling of soldering iron:                      | 56 |
| 1.     | Keep the iron in place                           | 58 |
| 2.     | First, pull the solder away                      | 58 |
| 11.2   | References:                                      | 59 |
| 12.    | OHM'S LAW  | 60 |
| 12.0   | Abstract:  | 60 |
| 12.1   | Basic concepts:                                  | 60 |
| 12.2   | Performing experiment of Ohm's law               | 61 |
| 12.3   | References:                                      | 61 |
| 13.    | USING THE MULTI-METER FOR OHM'S LAW:             | 62 |
| 13.0   | Abstract:  | 62 |
| 13.1   | Measuring the voltage across a resistor          | 62 |
| 13.2   | Experimental set up                              | 63 |
| 13.3   | Exercise   | 64 |
| 13.4   | References                                       | 64 |
| 14.    | VOLTAGE DIVIDER RULE (VDR)                       | 65 |
| 14.0   | Abstract:  | 65 |
| 14.1   | Basic concepts:                                  | 65 |
| 14.2   | Equipment and materials required are as follows: | 65 |

|      |   |    |
|------|---|----|
| 14.3 | Conclusion.....                                       | 68 |
| 14.4 | References: .....                                     | 68 |
| 15.  | <b>COMMON EMITTER AMPLIFIER WITH FIXED BIAS</b> ..... | 69 |
| 15.0 | Abstract: .....                                       | 69 |
| 15.1 | Introduction .....                                    | 69 |
| 15.2 | Experimental setup .....                              | 70 |
| 15.3 | Merits: .....   | 73 |
| 15.4 | Demerits: .....                                       | 73 |
| 15.5 | Usage: .....  | 74 |
| 15.6 | References: .....                                     | 74 |
| 16.  | <b>COMMON EMITTER AMPLIFIER WITH SELF BIAS</b> .....  | 75 |
| 16.0 | Abstract: .....                                       | 75 |
| 16.1 | Basic Circuit: .....                                  | 75 |
| 16.2 | Bias Design: .....                                    | 76 |
| 16.3 | Merits .....  | 76 |
| 16.4 | Mathematical Approach .....                           | 77 |
| 16.5 | References: .....                                     | 77 |
| 17.  | <b>COMMON COLLECTOR TRANSISTOR AMPLIFIER</b> .....    | 78 |
| 17.0 | Abstract: .....                                       | 78 |
| 17.1 | Introduction: .....                                   | 78 |
| 17.2 | Parts and equipment: .....                            | 78 |
| 17.3 | Experimental setup .....                              | 79 |
| 17.4 | Results and measurements: .....                       | 79 |
| 17.5 | References: .....                                     | 81 |
| 18.  | <b>DARLINGTON COMMON EMITTER</b> .....                | 82 |
| 18.0 | Abstract: .....                                       | 82 |
| 18.1 | Experimental setup: .....                             | 83 |
| 18.2 | Biasing Design:.....                                  | 84 |
| 18.3 | Design of R1& R2: .....                               | 84 |



|      |                                |    |
|------|--------------------------------|----|
| 18.4 | Tabular column:.....           | 84 |
| 18.5 | Calculation: .....             | 85 |
| 18.6 | Procedure:.....                | 85 |
| 18.7 | Result: .....                  | 86 |
| 18.8 | References: .....              | 86 |
| 19.  | CLASS-A AMPLIFIER .....        | 87 |
| 19.0 | Abstract: .....                | 87 |
| 19.1 | Apparatus Required .....       | 87 |
| 19.2 | Bias design: .....             | 88 |
| 19.3 | DESIGN OF R1 & R2: .....       | 88 |
| 19.4 | Tabular column:.....           | 89 |
| 19.5 | Theory:.....                   | 90 |
| 19.6 | Procedure:.....                | 90 |
| 19.7 | Result: .....                  | 91 |
| 19.8 | References: .....              | 91 |
| 20.  | CLASS – B POWER AMPLIFIER..... | 92 |
| 20.0 | Abstract: .....                | 92 |
| 20.1 | Apparatus Required: .....      | 92 |
| 20.2 | Theory: .....                  | 93 |
| 20.3 | Procedure:.....                | 93 |
| 20.4 | Tabular column:.....           | 95 |
| 20.5 | Formula: .....                 | 96 |
| 20.6 | Result: .....                  | 96 |
| 20.7 | References: .....              | 96 |
| 21.  | VOLTAGE FOLLOWER.....          | 97 |
| 21.0 | Abstract: .....                | 97 |
| 21.1 | VOLTAGE FOLLOWER .....         | 97 |
| 21.2 | Experiment: .....              | 98 |
| 21.3 | Tabular column: .....          | 99 |

|      |  |     |
|------|--|-----|
| 21.4 | Formula: .....                             | 99  |
| 21.5 | References: .....                          | 100 |
| 22.  | INVERTING AMPLIFIER .....                  | 101 |
| 22.0 | Abstract: .....                            | 101 |
| 22.1 | Inverting amplifier: .....                 | 101 |
| 22.2 | EXPERIMENT: .....                          | 102 |
| 22.3 | References: .....                          | 104 |
| 23.  | SUMMING AMPLIFIER .....                    | 105 |
| 23.0 | Abstract: .....                            | 105 |
| 23.1 | Summing amplifier: .....                   | 105 |
| 23.2 | EXPERIMENT .....                           | 107 |
| 23.3 | References: .....                          | 107 |
| 24.  | SUBTRACTOR OR DIFFERENTIAL AMPLIFIER ..... | 108 |
| 24.0 | Abstract: .....                            | 108 |
| 24.1 | Differential amplifier: .....              | 108 |
| 24.2 | EXPERIMENT: .....                          | 110 |
| 24.3 | References: .....                          | 110 |
| 25.  | INTEGRATOR .....                           | 111 |
| 25.0 | Abstract: .....                            | 111 |
| 25.1 | INTEGRATOR .....                           | 111 |
| 25.2 | EXPERIMENT: .....                          | 114 |
| 25.3 | References: .....                          | 114 |
| 26.  | DIFFERENTIATOR .....                       | 115 |
| 26.0 | Abstract: .....                            | 115 |
| 26.1 | Description: .....                         | 115 |
| 26.2 | EXPERIMENT: .....                          | 117 |
| 26.3 | References: .....                          | 120 |
| 27.  | COMPARATOR .....                           | 121 |
| 27.0 | Abstract: .....                            | 121 |

27.1 Description ..... 121

27.2 References: ..... 122

28. ACTIVE LOW PASS FILTER..... 123

28.0 Abstract: ..... 123

28.1 Description: ..... 123

28.2 References: ..... 128

29. ACTIVE HIGH PASS FILTER..... 129

29.0 Abstract: ..... 129

29.1 Description: ..... 129

29.2 References: ..... 135

30. ACTIVE BAND PASS FILTER..... 136

30.0 Abstract: ..... 136

30.1 Description: ..... 136

30.2 Resonant Frequency ..... 139

30.3 References: ..... 141

# 19. CLASS-A AMPLIFIER

Asadullah Shah and Muniba Shaikh

Department of Computer Science, Kulliyyah of Information and  
Communication Technology,  
International Islamic University of Malaysia,  
Malaysia

## 19.0 Abstract:

The class-A amplifier is the most common and simplest form of power amplifier that uses the switching transistor in the standard common emitter circuit. The transistor is always biased "ON" so that it conducts during one complete cycle of the input signal waveform producing minimum distortion and maximum amplitude to the output. Class A power amplifier output stages may use a single power transistor or pairs of transistors connected together to share the high load current. When an amplifier is biased such that it always operates in the linear region where the output signals is an amplifier replica of the input signal, it is a Class A amplifier.

## 19.1 Apparatus Required

| S.No | Equipment                     | Range/ Details  | Quantity |
|------|-------------------------------|---|----------|
| 1.   | Transistors                   | BC 107  | 1        |
| 2.   | Resistor                      | 1 K $\Omega$ , 4.7K $\Omega$ , 47K $\Omega$ , 10 K $\Omega$ all are $\frac{1}{4}$ W | 1        |
| 3.   | Capacitor                     | 47 $\mu$ F, 100 $\mu$ F   | 1        |
| 4.   | CRO                           | (0-20MHz)   | 1        |
| 5.   | AFO                           | (0-1MHz)  | 1        |
| 6.   | RPS                           |   | 1        |
| 7.   | Connecting wires & Breadboard |   |          |